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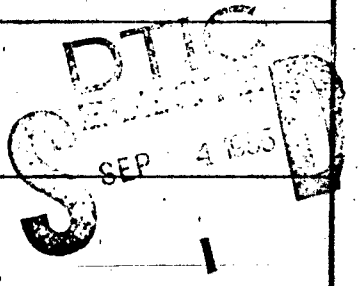

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This TOP prescribes methods for evaluating nuclear, biological, and chemical (NBC) decontamination equipment in the natural cold regions environment. It contains procedures for evaluating storage, transportation, environmental performance, logistic supportability, reliability, human factors, and safety. It describes the necessary facilities and instrumentation requirements for test accomplishment.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

AMSTE-RP-702-102

*Test Operations Procedure 8-4-007 17 May 1985
AD No.

COLD REGIONS ENVIRONMENTAL TEST OF NUCLEAR, BIOLOGICAL, AND CHEMICAL DECONTAMINATION EQUIPMENT

1. SCOPE

This TOP prescribes methods for evaluating nuclear, biological, and chemical (NBC) decontamination equipment in the natural cold regions environment. It contains procedures for evaluating storage, transportation, environmental performance, logistic supportability, reliability, human factors, and safety. It describes the necessary facilities and instrumentation requirements for test accomplishment.

2. FACILITIES AND INSTRUMENTATION

2.1 FACILITIES

Item	Requirement
Storage area	Secure, unsheltered storage area which is fully exposed to the environment.

*This TOP supersedes MTP/TOP 8-4-007, dated 29 August 1969.

Item	Requirement
Vehicles	Tactical wheeled or tracked vehicles on which the decontamination equipment is mounted. UH-1 Aircraft
Decon area	Clear area at least one kilometer from potable water and about one hectare in size.

2.2 Instrumentation

Item	Requirement
Flow measurement transducers	Measure flow to ±10% of rated flow.
Thermocouples	Accurate to 1°C (2°F)
Cold-Start Instrumentation	Depends on types of equipment.
Event recorder and dataloggers	As required.
Meteorological equipment	Standard surface observation data requirements for temperature, winds and humidity.
Noise meter	Capable of measuring A-weighted sound level and performing octave band analysis.

3. PREPARATION FOR TEST

3.1 Calibration. All instrumentation scheduled to be used will be calibrated and tagged.

3.2 Storage site. A secure storage site which is fully exposed to the natural environment will be located.

3.3 Decontamination site. A decontamination site will be located in a remote area, away from all buildings, parking lots, inhabited areas and at least 1 kilometer (0.6 mi) from any water source such as lakes, streams or wells. To minimize possible damage to the environment, the site should be in a cleared, well drained area which is free of permafrost. If testing involves use of decontaminants that are harmful to the environment and which cannot be neutralized, it may be necessary to construct a drain and sump to collect the decontaminant for disposal.

3.4 Test data. A detailed test plan will be developed, coordinated and approved prior to testing. Data forms will be developed, approved and printed so that they are available prior to beginning the test. Software needed to handle test data will be developed prior to the start of testing. Human factors checklists and questionnaires will also be designed in accordance with TOP 1-2-610[1], Human Factors Engineering.

3.5 Test Documentation. In addition to the detailed test plan, a safety release, an environmental impact assessment, a system support package, and funding will be on hand before beginning the test.

4. TEST CONTROLS

4.1 Sample size. Depending on reliability requirements, cost and prototype availability, a minimum of five test items should be allocated for this test. Test items should be new, or reconditioned if shipped from another test agency, and should be representative of the population from which they were drawn.

4.2 Air temperatures. All tests will be conducted within the storage and operation temperature limits specified in the requirements documents. Missions will not be started unless temperatures are within, and expected to remain within, the required limits. If ambient air temperatures unexpectedly change during a mission, do the following: (1) continue mission to completion if temperature rises above upper limit, or (2) stop mission and bring test items inside a building or shelter if temperatures drop below the lower limit.

4.3 Test personnel. All operators and maintainers will be of the proper military occupational specialty (MOS) and will be dressed with identical types and amounts of appropriate military standard cold weather clothing and mission oriented protective posture (MOPP IV) gear when operating the decontamination equipment.

5. PERFORMANCE TEST

5.1 Preoperational Inspection

5.1.1 Method

5.1.1.1 Upon receipt, all packaging will be inspected and any damage or deterioration will be noted and photographed. The test items will then be unpackaged, thoroughly inspected, and any discrepancies in number of items expected or listed in the System Support Package (SSP) will be reported. Each major component will be measured and weighed. Identification photographs will be obtained.

[1]Footnote numbers match those in appendix D, references.

5.1.1.2 If permanent serial numbers are not already present on the test items, test identification numbers will be assigned and the test items will be marked with permanent ink or by another suitable method.

5.1.2	Data Required	Tolerances
a.	Test item dimensions	1 cm (0.4 in)
b.	Test item weight	0.1 kg (0.2 lb)
c.	Test item serial numbers	NA
d.	Description of missing components	NA
e.	Description, with photographs, of damage.	NA

5.2 NEW EQUIPMENT TRAINING

5.2.1 Method

Operators and maintainers will be trained on the use and maintenance of the test items. Normally this training is performed on-site by the developer or a contractor at the start of the test season. Military personnel of the proper MOS will be trained, as well as other test team personnel. The Test Officer will subjectively evaluate the adequacy of the training and will fully document any problems that occur with the training or with the operation of the test items during training. The adequacy of operator and maintenance literature, from a training standpoint, will also be evaluated.

5.2.2	Data Required	Tolerances
a.	Number of personnel trained	NA
b.	Names and MOS's of personnel trained	NA
c.	Hours of training:	
	(1) Lectures	±0.1 hr.
	(2) Hands-on	±0.1 hr.
	(3) Maintenance	±0.1 hr.
d.	Subjective evaluation of training	NA
e.	Description of training problems	NA

	Data Required	Tolerances
f.	Hours test items operated during training	±1 hr.

5.3 Storage and Transportation

5.3.1 Method

5.3.1.1 Storage: Depending upon the availability of test items, a sample of decontamination equipment will be placed in secure open storage for a minimum of 60 days. As explained in paragraph 4.2, care will be taken to assure that the test items are not exposed to temperatures lower than those specified in the requirements document. All test items will be deserviced in accordance with operator and maintenance instructions prior to being placed in storage. Adequacy of deservicing instructions will be evaluated, along with any evidence of deterioration or cold related malfunctions of the test item resulting from storage. At the completion of storage, the test items will be carefully inspected, photographed (if necessary to document damage), serviced, and operated for one complete mission.

5.3.1.2 Wheeled vehicle transport: If a mission profile is not available, a minimum of one test item in the deserviced state and one containing decontaminant in the operational-ready state, will be blocked and braced (or carried in the manner prescribed in the operators manual), in the cargo area of a tactical 1¼-ton truck (or truck of appropriate cargo capacity), and transported for 300 kilometers (186 mi) over snow-covered, secondary, gravel roads while the ambient air temperature is within +9 centigrade degrees (+15 F degrees) of the lower operating limit specified in the requirement document. At completion of the mileage, the test items will be thoroughly inspected, any damage photographed, and the units will be operated for one mission.

5.3.1.3 Tracked vehicle transport: If a mission profile is not available, testing specified in para 5.3.1.2 for wheeled vehicle transport will be repeated using an M113A1 armored personnel carrier, or equivalent, except that mileage will be reduced to 150 kilometers (93 mi), 50 percent of which will be on cross-country trails. Truck mounted or large skid-mounted decontaminating apparatuses which do not meet weight or space limits of the tracked carrier will not be tested in this manner.

5.3.1.4 Helicopter transport: Testing described in para 5.3.1.2 for wheeled vehicles will be repeated, if applicable, for a 2-hour flight in a UH-1 helicopter, or equivalent, during low temperature conditions.

5.3.1.5. Man-pack: If designed to be man-packed, at least two units will be carried while snowshoeing and skiing. The decon units will be carried in a tactical configuration as specified in the operators manual for at least 4

hours for each mode of carry. Difficulties in carrying or using the test items will be fully documented by written records and video, as appropriate.

5.3.2	Data Required	Tolerances
a.	Storage duration	±0.5 day
b.	Storage temperatures:	
	(1) Daily range	±1°C (±2°F)
	(2) Daily average	±1°C (±2°F)
c.	Transportation data:	
	(1) Date and place	NA
	(2) Type transport	NA
	(3) Test item serial numbers	NA
	(4) Mileage (km)	±0.5%
	(5) Terrain description	NA
	(6) Snow type and average depth	±0.5 cm (±0.2 in)
d.	Daily log forms (Appendix A)	NA
e.	Description of all malfunctions	NA
f.	Photographs of damage	NA

5.4 Environmental Performance

5.4.1 Method

The environmental performance test is for evaluating the ability of the decontamination equipment to perform satisfactorily on a sustained basis under natural cold regions conditions. It provides most of the data for evaluating reliability. The maximum number of test items available should be used on this test. Test items will be kept outside, in an unsheltered area at all times unless necessary to bring inside for maintenance or to avoid exposures to temperatures below the specified limits. If a mission profile is provided, it will be followed as closely as possible. No toxic agents will be used, but decontamination of simulants may be specified for some items. If not, the ability of the item to remove dirt, grease, and area coverage will be determined. The exact methods to be used will be

highly dependent upon the type of equipment and mission profiles. General methods, geared to several types of decontamination equipment, are as follows:

a. Expendable items: Some decontamination equipment is intended for one-time use and is expendable. Testing such equipment consists of using it on the prescribed surfaces until the decontaminant is expended. This should be accomplished within +9 centigrade degrees (+15 F degrees) of the lower operating limit of the equipment. If sample size permits, additional units can be tested at higher temperatures for comparison purposes. Application times, difficulties and area coverage will be noted.

b. Portable refillable items: Small refillable decontamination devices may be repeatedly used by refilling with fresh decontaminant and, possibly, other expendables such as pressure bottles, seals or activators. Testing procedures are identical to those in para 5.4.1a, except that fewer items can be tested since the same items may be used serveral times. It also allows more trials for a higher confidence level. If large quantities or environmentally harmful decontaminants are used, it will be necessary to either recover and neutralize or use it only in a remote disposal area.

c. Engine-driven items: Engine-driven decontamination equipment will be tested in general accordance with the procedures in para 5.4.1a, but must be expanded to evaluate the following:

(1) Engine cold starting: perform as specified in TOP 2-2-650[2], Engine, Cold-starting and Warmup Tests.

(2) Decontaminant mixing/filling. Evaluate ease of filling and mixing decontaminants at low temperatures while operators wear the cold-dry uniform.

(3) Heaters. Determine adequacy of heaters for keeping liquid decontaminants from freezing at lowest specified operating temperature

(4) Values and flow control equipment. Test at lowest specified operating temperature and observe for proper operation, hose flexibility, leakage, ease of adjustment and durability of materials.

(5) Draining system. Perform draining cycle and observe for ease, adequacy and completeness. Perform at lower operating temperature limit and see if components freeze up or are otherwise adversely affected. Adequacy of winterization procedures will be evaluated.

Usually, engine-driven decontamination equipment involves the use of large quantities of decontaminant. To minimize environmental effects, most missions should be done with water and/or a harmless simulant, with occasional limited use of the actual decontaminant. In the absence of guidance

in a mission profile, at least 22 missions should be performed on two test items.

d. Auxiliary equipment: Special tests are required for evaluating auxiliary equipment that may be supplied with the engine-driven decontamination equipment. Examples are personnel shower systems, spray bars, and steam generators. Generally, these auxiliary items should be operated for a portion of the missions described above in para 5.4.1c and as governed by the mission profile.

5.4.2.2 Data Required	Tolerances
a. For each mission:	
(1) Date/time/item no.	NA
(2) Air temperatures (range and average)	±1°C (±2°F)
(3) Windspeed and direction	±0.5 m/sec (1.1 mph) and ±10°
(4) Preparation time	±1 min
(5) Operation time	±1 min
(6) Volume decontaminant dispersed	±2 %
(7) Problems encountered	NA
(8) Type surfaces decontaminated	NA
b. For engine-driven items:	
(1) Cold start attempts/completions	NA
(2) Oil sump temperatures	±1°C (±2°F)
(3) Decontaminant temperatures	±1°C (±2°F)
(4) Battery electrolyte temperatures	±1°C (±2°F)
(5) Flow rate from pump	±2%
(6) Water pressure from pump	±2%
(7) Warm-up time	±1 min
(8) Fuel consumption rate	±0.1 liter/hr (0.026 gph)

Data Required	Tolerances
(9) Time required to shut down	±0.1 hr
(10) Hours operated	±1 hr
(11) Description of problems encountered	NA

c. For auxiliary items:

(1) Water temperatures	±1°C (±1°F)
(2) Water pressure (output)	±2 %
(3) Area coverage	±5%
(4) Adequacy of output	NA
(5) Description of problems encountered	NA

5.5 Logistic Supportability: Logistic supportability testing will be performed in accordance with TOP 8-4-015[3], Cold Regions Logistic Supportability Testing of Chemical, Biological and Radiological Defense Equipment.

5.6 Reliability

5.6.1 Method

Reliability data will be accumulated from all testing, but especially from the environmental performance subtest (para 5.4). All test incidents will be recorded and reported in accordance with AMC Regulation 70-13[4] and TECOM Supplement 1. An incident is defined as the occurrence or detection of any actual, intermittent or incipient malfunction, safety hazard, or degradation in the performance of the system. All failures, stoppages, or malfunctions will be scored using RAM failure definitions or scoring criteria, as required.

5.6.2 Data Required

a. Documentation of each failure, to include:

(1) Unit serial number

(2) Date and time

(3) Operating time at failure

(4) Equipment performance report reference number

(5) Description of failed part

(6) Symptoms of failure

(7) Perceived cause of failures

b. Failure analysis and scoring.

5.7 Human factors

5.7.1 Method

5.7.1.1 All of the testing performed in the aforedescribed testing will be monitored by a qualified human factors engineer to observe and evaluate human factors characteristics and to obtain data for completion of the human factors checklist. In addition, test personnel will continuously observe and comment on the ease of preparation, servicing, operation, transport, and maintenance of the test items. Special attention will be given to observing the ease of operation and maintenance while wearing appropriate components of the cold-dry uniform and/or CB protective clothing, including different types of headwear. The human factors checklists (appendix B) will be used as a guide in evaluating human factors engineering characteristics.

5.7.1.2 A human factors questionnaire designed in accordance with TOP 1-2-610, will be administered to all operators at mid-test and again at test completion. A sample questionnaire/interview guide is at appendix C.

5.7.1.3 Steady-state noise levels of engine-driven decontamination equipment will be measured in accordance with TOP 1-2-608[5], Sound Level Measurements.

5.7.2 Data Required

a. Demographic data on test participants.

b. Completed human factors checklist.

c. Summary of the results of observations, interviews, questionnaires, and checklists completed during test.

d. Photographs depicting typical human factors design and performance problems that increase human error or cause problems in performing necessary operator or maintenance tasks.

e. Anthropometric measurements and description of problems experienced in handling test items.

f. Steady-state noise levels of test items in normal operation.

5.8 Safety

5.8.1 Method

5.8.1.1 Operation and maintenance of the test item will be observed throughout testing to identify any features which constitute a safety hazard.

5.8.1.2 The safety aspects of any safety documentation and the operator's and maintenance manuals will be analyzed for adequacy and completeness.

5.8.1.3 All instances of injury, accidents, or potential or actual safety hazards will be documented.

5.8.2 Data Required

a. Identification and description of safety hazards encountered in test.

b. Adequacy of safety instructions and warning plates.

c. Verification of the adequacy of safety documentation and manuals provided by the developer.

6. DATA REDUCTION AND PRESENTATION

6.1 Preoperational Inspection. The data, observations, and photographs will be used to determine and document receipt condition of the test items and to establish that all test items are in suitable condition to begin testing. Data will be presented in narrative and tabular format to summarize results.

6.2. New Equipment Training. The adequacy of the training will be subjectively determined and fully documented in the report in narrative form.

6.3 Storage and Transportation. Quantitative data will be recorded on the daily log forms and then tabulated and summarized in tables. Additionally if sufficient data are available, statistical comparisons of data will be made to determine if specific modes of transport resulted in increased failures or other operational anomalies. Damage, malfunctions, or difficulties will be reported narratively and by use of appropriate photographs.

6.4 Environmental Performance. Data recorded on the daily log forms will be tabulated and grouped by specific environmental parameters such as temperature category, wind speed, etc., to see if the results were affected by those environmental factors. Statistical techniques will be used that are

appropriate to the amount and distribution of data. The results will be discussed narratively in the report and will be used to evaluate the test criteria.

6.5 Logistic Supportability. Data reduction and presentation will be as specified in TOP 8-4-015.

6.6 Reliability. Data will be compiled and presented in tabular form. All operational hours will be accumulated and combined for reliability calculations. Data will be analyzed to determine the correct failure distribution. As a minimum the point estimates of the mean-time-between-failures will be calculated, along with lower one-sided confidence limits.

6.7 Human Factors. Data obtained from checklists and questionnaires will be summarized and presented in narrative form. Questionnaires will be summarized with average ratings presented. Noise levels will be tabulated and compared to the standards in TOP 1-2-608. Additionally, all human factor observations will be reported narratively, with photographs, if applicable.

6.8 Safety. All safety hazards or incidents will be fully documented and reported narratively. Safety incidents will be classified as to severity and frequency in accordance with MIL-STD-882[6].

Recommended changes to this publication should be forwarded to Commander, US Army Test and Evaluation Command, ATTN: AMSTE-AD-M, Aberdeen Proving Ground, MD 21005-5055. Technical information may be obtained from the preparing activity: Commander, US Army Cold Regions Test Center, ATTN: STECR-TA, APO Seattle WA 98733-7850. Additional copies are available from the Defense Technical Information Center, Cameron Station, Alexandria, VA 22304-6145. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX A - DAILY LOG FORM (SAMPLE)

DAILY LOG FORM

Date_____ Test Site_____

Decon Apparatus Serial No._____ Operating Hours: Start_____

Operator(s)_____ Finish_____

_____ Power Source_____

_____ Decon used_____

Amount_____

Surface_____

Time to Service_____minutes Warm-up Time_____minutes

Ambient Air Temperature: Range_____°F to _____°F; Average_____°F

Atmospheric Conditions (specify duration in minutes):

_____Clear	_____Dusty	_____Blowing Snow
_____Rain	_____Wet Fog	_____Hail
_____Falling snow	_____Ice Fog	_____Other (specify)

Malfunctions (explain):

Remarks:_____

APPENDIX B - TASK AND DESIGN CHECKLIST - MAINTAINABILITY

TASK CHECKLIST
MAINTAINABILITY

Test Item_____ _____Observer_____Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Check tightness of fasteners and connectors.	[ ]	[ ]	[ ]	[ ]	
2. Determine status of expendable materiels.	[ ]	[ ]	[ ]	[ ]	
3. Verify operational status of displays.	[ ]	[ ]	[ ]	[ ]	
4. Remove and replace minor items (lightbulbs, filters, etc.)	[ ]	[ ]	[ ]	[ ]	
5. Lubricate.	[ ]	[ ]	[ ]	[ ]	
6. Add expendables.	[ ]	[ ]	[ ]	[ ]	
7. Tighten fasteners and connectors.	[ ]	[ ]	[ ]	[ ]	
8. Monitor displays.	[ ]	[ ]	[ ]	[ ]	
9. Utilize visual and auditory cues.	[ ]	[ ]	[ ]	[ ]	
10. Detect changes in system operation.	[ ]	[ ]	[ ]	[ ]	
11. Visually inspect components.	[ ]	[ ]	[ ]	[ ]	
12. Apply auxiliary test equipment to test points.	[ ]	[ ]	[ ]	[ ]	
13. Obtain readouts.	[ ]	[ ]	[ ]	[ ]	

Man/Item Tasks	S	M	U	NA	Remarks
14. Open and secure accesses.	[ ]	[ ]	[ ]	[ ]	
15. Remove fasteners and connectors.	[ ]	[ ]	[ ]	[ ]	
16. Attach cables, hoses and wires.	[ ]	[ ]	[ ]	[ ]	
17. Verify adequacy of replacement.	[ ]	[ ]	[ ]	[ ]	
18. Repair component while mounted on item.	[ ]	[ ]	[ ]	[ ]	

TASK CHECKLIST
OPERABILITY

Test Item_____ Observer_____ Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Unstow or stow components.	[ ]	[ ]	[ ]	[ ]	
2. Read and interpret instructions and technical manuals.	[ ]	[ ]	[ ]	[ ]	
3. Identify parts.	[ ]	[ ]	[ ]	[ ]	
4. Connect components.	[ ]	[ ]	[ ]	[ ]	
5. Position for use.	[ ]	[ ]	[ ]	[ ]	
6. Tighten or loosen fasteners.	[ ]	[ ]	[ ]	[ ]	
7. Set and adjust controls.	[ ]	[ ]	[ ]	[ ]	
8. Determine status of expendables.	[ ]	[ ]	[ ]	[ ]	
9. Open or close access covers.	[ ]	[ ]	[ ]	[ ]	
10. Remove or replace filler caps.	[ ]	[ ]	[ ]	[ ]	
11. Start engine.	[ ]	[ ]	[ ]	[ ]	
12. Ignite pilot light or burner.	[ ]	[ ]	[ ]	[ ]	
13. Turn on electrical power.	[ ]	[ ]	[ ]	[ ]	
14. Operate equipment according to operating manuals.	[ ]	[ ]	[ ]	[ ]	
15. Manipulate controls.	[ ]	[ ]	[ ]	[ ]	
16. Observe and monitor displays.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
Labels, Manuals, Markings

Test Item_____Observer_____Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Controls, displays and other items of equipment are clearly marked and labeled except in cases where use is obvious to the operator.	[ ]	[ ]	[ ]	[ ]	
2. Labels are on or near the item to be identified.	[ ]	[ ]	[ ]	[ ]	
3. Labels do not cover any other information and are not located behind controls. They can be seen easily by the operator and are not obscured by the operator's hand activating a control.	[ ]	[ ]	[ ]	[ ]	
4. Labels are not covered by other equipment and are located on the flat test, least cluttered and cleanest surface available.	[ ]	[ ]	[ ]	[ ]	
5. Labels are mounted so that they cannot be accidentally damaged or removed.	[ ]	[ ]	[ ]	[ ]	
6. Where instructions are lettered on hinged door, lettering is set so that it can be read when the door is open.	[ ]	[ ]	[ ]	[ ]	
7. Labels are easily read at operational reading distances with vibration/motion and lighting levels taken into consideration.	[ ]	[ ]	[ ]	[ ]	

Man/[illegible]m Tasks	S	M	U	NA	Remarks
8. For dark adaptation, letters are visible and do not interfere with night vision.	[ ]	[ ]	[ ]	[ ]	
9. Markings and tags are as permanent as the equipment to which applied and able to withstand environmental and cleaning conditions.	[ ]	[ ]	[ ]	[ ]	
10. Labels are accessible and visible during maintenance.					
11. Electrical receptacles are clearly marked with voltage, phase and frequency characteristics.	[ ]	[ ]	[ ]	[ ]	
12. Pipe, hose and tube lines are clearly labeled as to contents, pressure, temperature, and hazard.	[ ]	[ ]	[ ]	[ ]	
13. Warning placards are well illuminated.	[ ]	[ ]	[ ]	[ ]	
14. Circuit breakers are labeled and easily accessible.	[ ]	[ ]	[ ]	[ ]	
15. Markings are visible in ice or snow.	[ ]	[ ]	[ ]	[ ]	
16. Manuals used in the field are easily handled with cold/wet or arctic mittens.	[ ]	[ ]	[ ]	[ ]	
17. Label adhesives adhere when cold.	[ ]	[ ]	[ ]	[ ]	
18. Cold weather instructions are included with item.	[ ]	[ ]	[ ]	[ ]	
19. Items retrofitted for cold weather usage have instructions for use in cold weather included in standard manuals.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
Displays

Test Item_____ Observer_____ Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Relationship between the display and its associated controls is unmistakable in terms of:	[ ]	[ ]	[ ]	[ ]	
a. The proper control to use.	[ ]	[ ]	[ ]	[ ]	
b. Direction of movement of the control.	[ ]	[ ]	[ ]	[ ]	
c. Rate and limits of movement of the control.	[ ]	[ ]	[ ]	[ ]	
2. Controls are located adjacent to (either under or to right of) associated displays.	[ ]	[ ]	[ ]	[ ]	
3. Displays used in system checkout are located so they can be observed from one position.	[ ]	[ ]	[ ]	[ ]	
4. Meters, dials, and instruments are so sized/arranged that they can be read from the normal operating position.	[ ]	[ ]	[ ]	[ ]	
5. Frequently used displays are grouped together.	[ ]	[ ]	[ ]	[ ]	
6. Displays are located where they can be read to the required degree of accuracy.	[ ]	[ ]	[ ]	[ ]	

Man/Item Tasks	S	M	U	NA	Remarks
7. Unusual aids such as ladders, extra lighting, etc., are not needed to read or gain access to a display.	[ ]	[ ]	[ ]	[ ]	
8. Display scales are limited to only information needed to make a decision or take action. All needed information is presented.	[ ]	[ ]	[ ]	[ ]	
9. Failure in the unit is clearly shown or the operator is otherwise warned.	[ ]	[ ]	[ ]	[ ]	
10. The display pointer extends to but does not obscure the index mark width.	[ ]	[ ]	[ ]	[ ]	
11. Display pointer is mounted as close as possible to dial face to eliminate parallax and shadows.	[ ]	[ ]	[ ]	[ ]	
12. Illumination is uniform.	[ ]	[ ]	[ ]	[ ]	
13. Multiple displays grouped toge ther will have brightness uniformity across the range of full "ON" to full "OFF".	[ ]	[ ]	[ ]	[ ]	
14. Glare does not interfere with readability of the display at a location.	[ ]	[ ]	[ ]	[ ]	
15. Color coding is used where possible; unused scales are covered.	[ ]	[ ]	[ ]	[ ]	
16. Indicators used at night are dimmable (0.02-1.0 Ft-L).	[ ]	[ ]	[ ]	[ ]	
17. Internal instrument lighting is provided where effective.	[ ]	[ ]	[ ]	[ ]	
18. The information displayed is clear, specific, and usable. It is not redundant or degraded by vibration. It is at a level of accuracy required for the operator's action or decision.	[ ]	[ ]	[ ]	[ ]	

Man/Item Tasks	S	M	U	NA	Remarks
19. Dials are visible to arctic clothed user.	[ ]	[ ]	[ ]	[ ]	
20. Displays are readable under dark to bright glare conditions.	[ ]	[ ]	[ ]	[ ]	
21. Cover glass does not fog up.	[ ]	[ ]	[ ]	[ ]	
22. Displays do not freeze up.	[ ]	[ ]	[ ]	[ ]	
23. Gauges do not need recalibration at different temperatures.	[ ]	[ ]	[ ]	[ ]	
24. Alarms are audible over heater or motor noise while wearing ear coverings.	[ ]	[ ]	[ ]	[ ]	
25. Critical displays do not freeze at any one setting.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
Controls

Test Item_____ Observer_____ Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Control relationship to its display is apparent.	[ ]	[ ]	[ ]	[ ]	
2. Controls are located so that they cannot be accidentally moved.	[ ]	[ ]	[ ]	[ ]	
3. Controls are marked to indicate in which direction to operate the control.	[ ]	[ ]	[ ]	[ ]	
4. Control/display groups used only for maintenance are not located in prime operating space.	[ ]	[ ]	[ ]	[ ]	
5. Controls used most often are located in the best position for ease of reaching and grasping.	[ ]	[ ]	[ ]	[ ]	
6. Sensitive adjustments are located or guarded to prevent accidental activation.	[ ]	[ ]	[ ]	[ ]	
7. Adequate control response feedback is provided.	[ ]	[ ]	[ ]	[ ]	
8. Range of control action does not interfere with other controls.	[ ]	[ ]	[ ]	[ ]	
9. Shape coded controls are visually and tactually identifiable.	[ ]	[ ]	[ ]	[ ]	
10. Switch legend is legible with or without internal illumination.	[ ]	[ ]	[ ]	[ ]	

Man/Item Tasks	S	M	U	NA	Remarks
11. Controls are usable in the time required despite inadvertent operation protection (guards).	[ ]	[ ]	[ ]	[ ]	
12. Latches on levers do not cause delay in operation.	[ ]	[ ]	[ ]	[ ]	
13. Critical controls are designed and located so that they are not susceptible to being moved accidentally.	[ ]	[ ]	[ ]	[ ]	
14. If there is a possibility of inadvertent activation causing a hazardous condition, controls are recessed or shielded by a physical barrier.	[ ]	[ ]	[ ]	[ ]	
15. Resistance is built in so that definite or sustained effort is required for activation.	[ ]	[ ]	[ ]	[ ]	
16. Controls can be reached by 5th percentile user wearing bulky or restrictive clothing.	[ ]	[ ]	[ ]	[ ]	
17. Tactile shape or size coding is recognizable when wearing arctic mittens.	[ ]	[ ]	[ ]	[ ]	
18. Controls are operable with arctic mittens or vapor barrier boots as applicable.	[ ]	[ ]	[ ]	[ ]	
19. Control separation is great enough to accommodate arctic mittens.	[ ]	[ ]	[ ]	[ ]	
20. Protected controls are usable with arctic mittens.	[ ]	[ ]	[ ]	[ ]	
21. Controls do not freeze up.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
Lines, Hoses, Cables

Test Item_____Observer_____Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Line fittings are standardized so that lines that differ in content are not interchangeable.	[ ]	[ ]	[ ]	[ ]	
2. Hand operation or common tools are used to tighten or loosen.	[ ]	[ ]	[ ]	[ ]	
3. Adequate space is provided to handle cables, lines, and hoses.	[ ]	[ ]	[ ]	[ ]	
4. Clearance between cables and controls is a minimum of three inches.	[ ]	[ ]	[ ]	[ ]	
5. Pipes and hoses are appropriately guarded if temperature accidentally may exceed 140°F(60°C) or if it exceeds 120°F(49°C) during handling.	[ ]	[ ]	[ ]	[ ]	
6. Line and cable attachment parts are reachable by user in bulky clothing.	[ ]	[ ]	[ ]	[ ]	
7. External connectors are operable by user wearing arctic mittens.	[ ]	[ ]	[ ]	[ ]	
8. Line and hose connectors are operable by user wearing arctic mittens.	[ ]	[ ]	[ ]	[ ]	
9. Lines and cables lying on ground or on snow are visible in traffic areas.	[ ]	[ ]	[ ]	[ ]	

Man/Item Tasks	S	M	U	NA	Remarks
10. Plastic or rubber hoses and cables do not stiffen in cold.	[ ]	[ ]	[ ]	[ ]	
11. Insulation remains intact in cold.	[ ]	[ ]	[ ]	[ ]	
12. Cables which are under tension do not break in extreme cold.	[ ]	[ ]	[ ]	[ ]	
13. Liquids cannot spill on personnel.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
Fasteners, Connectors

Test Item_____ Observer_____ Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Fastener and connector operating parts are easily accessible and visible.	[ ]	[ ]	[ ]	[ ]	
2. Connectors are physically different when lines carry different fluids.	[ ]	[ ]	[ ]	[ ]	
3. Fasteners require one turn maximum to tighten or to loosen.	[ ]	[ ]	[ ]	[ ]	
4. Adequate space is available to grasp connectors firmly.	[ ]	[ ]	[ ]	[ ]	
5. Access cover fasteners are of the captive type.	[ ]	[ ]	[ ]	[ ]	
6. Plugs and connectors are self-locking.	[ ]	[ ]	[ ]	[ ]	
7. Fasteners used outside are operable under all environmental conditions.	[ ]	[ ]	[ ]	[ ]	
8. Connectors are easily reached by user wearing bulky or restrictive clothing.	[ ]	[ ]	[ ]	[ ]	
9. Connectors and fasteners exposed to weather are shielded from ice and snow.	[ ]	[ ]	[ ]	[ ]	
10. Small parts handling is minimized.	[ ]	[ ]	[ ]	[ ]	

Man/Item Tasks	S	M	U	NA	Remarks
11. Fasteners are operable while wearing mittens.	[ ]	[ ]	[ ]	[ ]	
12. Tactile shape or size coding is recognizable when wearing arctic mittens.	[ ]	[ ]	[ ]	[ ]	
13. Connectors are separated by 3-inch minimum if operated with mittened hand.	[ ]	[ ]	[ ]	[ ]	
14. Connectors and fasteners are operable in the dark and do not freeze up.	[ ]	[ ]	[ ]	[ ]	
15. Tapes, glues and adhesives do not lose their adhesiveness in the cold.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
handles

Test Item_____ Observer_____ Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Handles and grasp areas are located relative to the center of gravity of the unit.	[ ]	[ ]	[ ]	[ ]	
2. Nonfixed handles (hinges, fold-out, etc.) have a stop position for holding the handle perpendicular to the surface on which it is mounted and are capable of being placed into position by one hand.	[ ]	[ ]	[ ]	[ ]	
3. Handles facilitate handling and carrying over snow-covered terrain.	[ ]	[ ]	[ ]	[ ]	
4. Handles are reachable by 5 percentile personnel wearing bulky or restrictive clothing.	[ ]	[ ]	[ ]	[ ]	
5. Handles accommodate arctic mittens.	[ ]	[ ]	[ ]	[ ]	
6. Hand grips have nonslip surface.	[ ]	[ ]	[ ]	[ ]	
7. Recessed handles cannot be clogged with ice or snow.	[ ]	[ ]	[ ]	[ ]	
8. Hinged and fold out handles do not freeze up.	[ ]	[ ]	[ ]	[ ]	
9. Collapsible handles can be erected while wearing arctic mittens.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
Accesses, Covers, Caps

Test Item_____Observer_____Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Instructions are visible when access cover is open.	[ ]	[ ]	[ ]	[ ]	
2. Allowance is made for mittened hand in externally located access.	[ ]	[ ]	[ ]	[ ]	
3. Caps and covers do not freeze up or clog with snow or ice.	[ ]	[ ]	[ ]	[ ]	

DESIGN CHECKLIST
Replaceable Units

Test Item_____Observer_____Date_____

The following tasks will be observed, performance will be rated as follows:

S = Satisfactory
M = Marginal
U = Unsatisfactory
NA = Not Applicable

Man/Item Tasks	S	M	U	NA	Remarks
1. Fill points and drains are reachable by 5th percentile personnel wearing restrictive or bulky clothing.	[ ]	[ ]	[ ]	[ ]	
2. Fasteners can be operated with arctic mittens and are not affected by freezing.	[ ]	[ ]	[ ]	[ ]	

APPENDIX C - HUMAN FACTORS SUBJECTIVE QUESTIONNAIRE

Test Item _____

Observer _____ Date _____

Question 1:
Reading warning or instruction labels was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 2:
Servicing the decon apparatus was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 3:
Reading display panels was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 4:
Connecting and disconnecting cables and hoses was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 5:
Accessibility of controls was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 6:
Use of the applicator was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 7:
During operation, the noise level was:

6 - Hardly Any Noise ____
5 - Some Noise ____
4 - Average Noise Level ____
3 - Somewhat Loud ____
2 - Moderately Loud ____
1 - Extremely Loud ____

Comments: _____

_____

_____

Question 8:
Protection of the operator from moving parts or electrical shock was:

6 - Excellent ____
5 - Very Good ____
4 - Adequate ____
3 - Not Quite Adequate ____
2 - Poor ____
1 - Extremely Poor ____

Comments: _____

_____

_____

Question 9:
Understanding the before, during, and after operation instructions was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 10:
Space provided for servicing the unit was:

6 - Excellent ____
5 - Very Satisfactory ____
4 - About Average ____
3 - Needs Improvement ____
2 - Not Very Satisfactory ____
1 - Very Poor ____

Comments: _____

_____

_____

Question 11:
How would you rate the overall ease of using the system?

6 - Extremely Good ____
5 - Very Good ____
4 - Good ____
3 - Poor ____
2 - Very Poor ____
1 - Extremely Poor ____

Comments: _____

_____

_____

Question 12:
How would you rate the overall effectiveness of the decon system?

6 - Extremely Good _____
5 - Very Good _____
4 - Good _____
3 - Poor _____
2 - Very Poor _____
1 - Extremely Poor _____

Comments: _____

_____

_____

HUMAN FACTORS ENGINEERING MAINTENANCE QUESTIONNAIRE

Test Item _____

Observer _____ Date _____

Question 1:
Determining the nature of the malfunction or service to be performed was:

6 - Extremely Easy	____
5 - Very Easy	____
4 - Easy	____
3 - Difficult	____
2 - Very Difficult	____
1 - Extremely Difficult	____

Comments: _____

_____

_____

Question 2:
Troubleshooting and/or maintenance procedures in the maintenance manuals were:

6 - Extremely Easy	____
5 - Very Easy	____
4 - Easy	____
3 - Difficult	____
2 - Very Difficult	____
1 - Extremely Difficult	____

Comments: _____

_____

_____

Question 3:
Assembly or disassembly of components was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 4:
Access to parts, components was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 5:
Mating of parts and components which were replaced and/or serviced was:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments: _____

_____

_____

Question 6:
Did personnel clothing or special purpose clothing interfere with performance or maintenance:

6 - Hardly Any Interference ____
5 - Very Little Interference ____
4 - About Average ____
3 - Some Interference ____
2 - Moderate Interference ____
1 - Extreme Interference ____

Comments:_____

_____

_____

Question 7: Procedures that require excessive physical effort, such as lifting without adequate handles and grasp area, space needed, angle of lift or twist were:

6 - Extremely Easy ____
5 - Very Easy ____
4 - Easy ____
3 - Difficult ____
2 - Very Difficult ____
1 - Extremely Difficult ____

Comments:_____

_____

_____

Question 8:
Workspace clearance during maintenance was:

6 - Excellent ____
5 - Very Good ____
4 - Adequate ____
3 - Not Quite Adequate ____
2 - Poor ____
1 - Extremely Poor ____

Comments:_____

_____

_____

Question 9:
Fatigue producing body or limb positions imposed during performing maintenance occur:

6 - Hardly Ever _____
5 - On Occasion _____
4 - About Average _____
3 - With Some Frequency _____
2 - Very Frequently _____
1 - Always _____

Comments: _____

_____

_____

Question 10.
Maintenance check points were:

6 - Excellent _____
5 - Very Good _____
4 - Adequate _____
3 - Not Quite Adequate _____
2 - Poor _____
1 - Extremely Poor _____

Comments: _____

_____

_____

Question 11:
Space and/or clearances for torque wrenches requiring 50 ft. lb. or more was:

6 - Excellent _____
5 - Very Good _____
4 - Adequate _____
3 - Not Quite Adequate _____
2 - Poor _____
1 - Extremely Poor _____

Comments: _____

_____

_____

Question 12:
Lubrication points (accessibility and/or visibility) were:

6 - Excellent ____
5 - Very Good ____
4 - Adequate ____
3 - Not Quite Adequate ____
2 - Poor ____
1 - Extremely Poor ____

Comments: _____

_____

_____

Question 13:
Fuzes and circuit breakers are designed and located so that replacing and resetting them is:

6 - Excellent ____
5 - Very Good ____
4 - Adequate ____
3 - Not Quite Adequate ____
2 - Poor ____
1 - Extremely Poor ____

Comments: _____

_____

_____

Question 14:
Built-in circuit testing features are:

6 - Excellent ____
5 - Very Good ____
4 - Adequate ____
3 - Not Quite Adequate ____
2 - Poor ____
1 - Extremely Poor ____

Comments: _____

_____

_____

Make any additional comments about improvements to the alarm based upon your experience with it.

APPENDIX D - REFERENCES

1. TOP 1-2-610, Human Factors Engineering, 30 November 1983.

2. TOP 2-2-650, Engine Cold-Starting and Warmup Tests, 18 July 1980.

3. TOP 8-4-015, Cold Regions Logistics Supportability Testing of Chemical, Biological and Radiological Defense Equipment, 26 October 1984.

4. AMC Regulation 70-13, Incidents Disclosed During Materiel Testing, 16 August 1982, w/TECOM Supplement 1, 12 April 1983.

5. TOP 1-2-608, Sound Level Measurements, 17 July 1981.

6. MIL-STD-882, System Safety Program for System and Associated Subsystems and Equipment, Requirements for, 28 June 1977.

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